Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3)

to be developed by the

Working Group on California Earthquake Probabilities (WGCEP)

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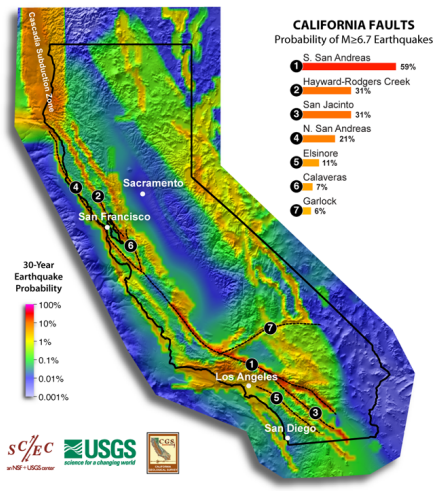
Presentation to Joint Meeting of NEPEC and CEPEC
November 4, 2009

SCEC-USGS-CGS Working Group on California Earthquake Probabilities (2007)

Uniform California Earthquake Rupture Forecast (UCERF2)



- **First uniform time-dependent earthquake rupture forecast for California**
- **Developed by multi-agency WGCEP with CEA support**
  - **Fully automated on the OpenSHA computational platform**
  - **Coordinated with 2008 release of National Seismic Hazard Mapping Program**
  - **Current basis for performance-based seismic design and CEA risk analysis**

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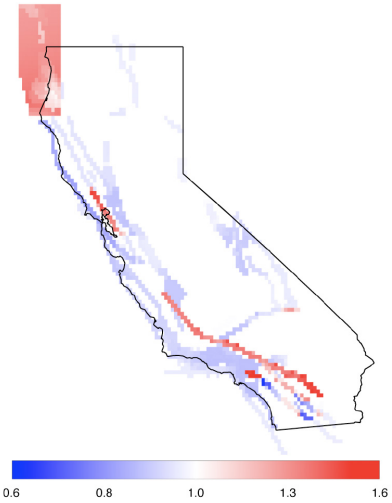
SCEC-USGS-CGS Working Group on California Earthquake Probabilities (2007)

Uniform California Earthquake Rupture Forecast (UCERF2)



Ratio of time-dependent to time-independent participation probabilities for M ≥ 6.7

Recommendations for improvement:

- **Include fault-to-fault ruptures**
- **Include earthquake clustering and triggering probabilities, including aftershocks**
- **Develop self-consistent stress-renewal models**
- **Understand time-dependence of historical seismicity**
- **Reconcile magnitude-area relationships**

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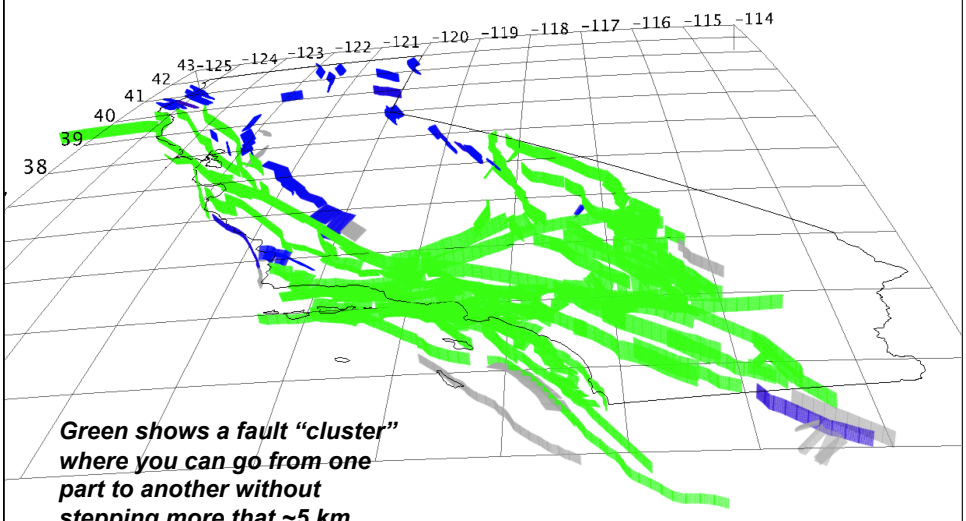
California's Active Faults are Clustered in Space



Green shows a fault "cluster" where you can go from one part to another without stepping more that ~5 km between faults.

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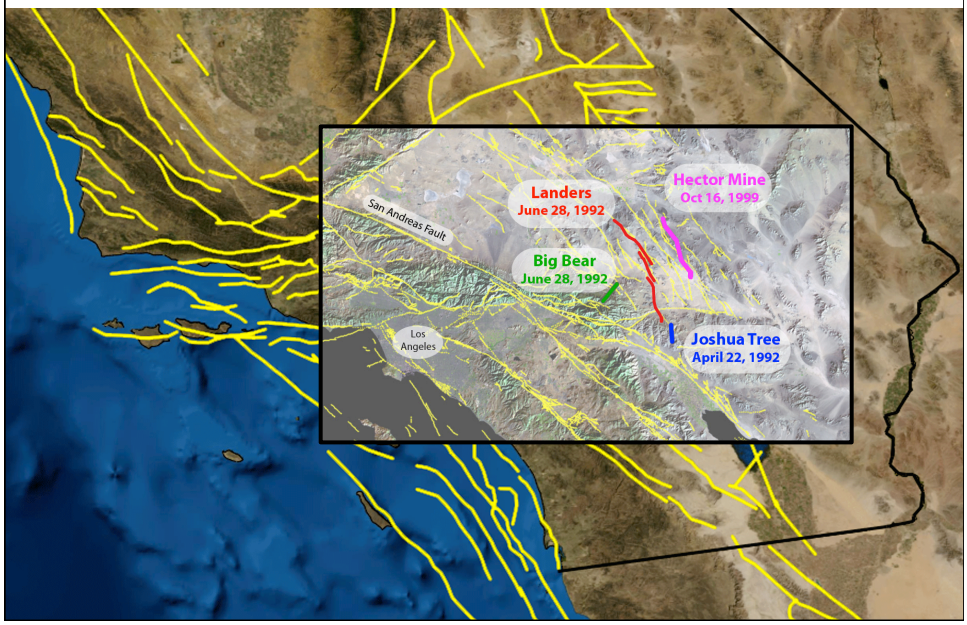
California Earthquakes are Clustered in Time and Space



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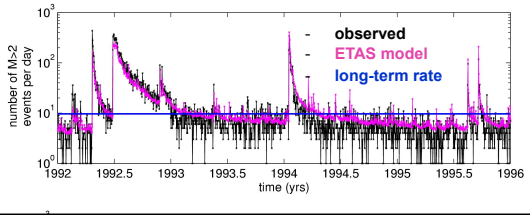
What If?

- **What if a M7.5 earthquake were to occur on a segment of the southern San Andreas fault?**
  - **UCERF2 would no longer be a valid forecast, because the earthquake itself would substantially modify future earthquake probabilities**
  - **Probability of a subsequent earthquake *at least as large* on the SAF fault (or elsewhere) would rise substantially**
  - **But by how much?**
    - ***Standard aftershock forecasts would be an inadequate basis for estimating this probability***

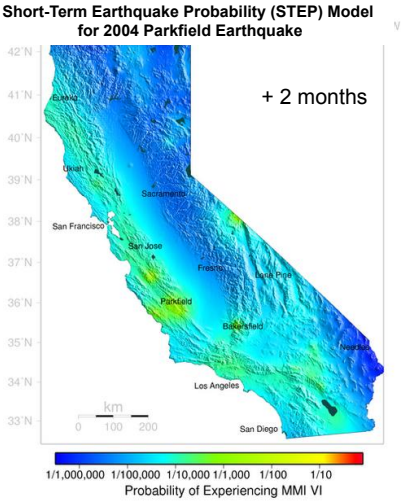
Need for a Dynamic Model

- **UCERF2 is a *static* model**
  - **represents the long-term "earthquake climate"**
  - **does not account for short-term "earthquake weather"**
- **UCERF3 will be a *dynamic earthquake forecast***
  - **will adapt rupture probabilities to changing seismic conditions**
  - **will be rapidly updated following a large earthquake**



Why now?

- **Operational models of earthquake triggering and clustering have been developed for California and are being prospectively tested by CSEP**



http://pasadena.wr.usgs.gov/step

Why now?

- **New data have been collected through the SoSAFE project that revise (upward) the probability of large earthquakes on the southern San Andreas fault**

Los Angeles Times

Unlocking the secrets of California's past earthquakes

Ricardo DeAratanha / Los Angeles Times

UC Irvine researcher Lisa Grant Ludwig leads a team of geologists who are trying to construct a history of earthquakes on the San Andreas Fault by reading lines of sediment in the earth. More photos >>>

Geologists are challenging the conventional wisdom about the section of the San Andreas fault in the Carrizo Plain. Their results could alter estimated probabilities of quakes in California.

By Jia-Rui Chong
June 21, 2009

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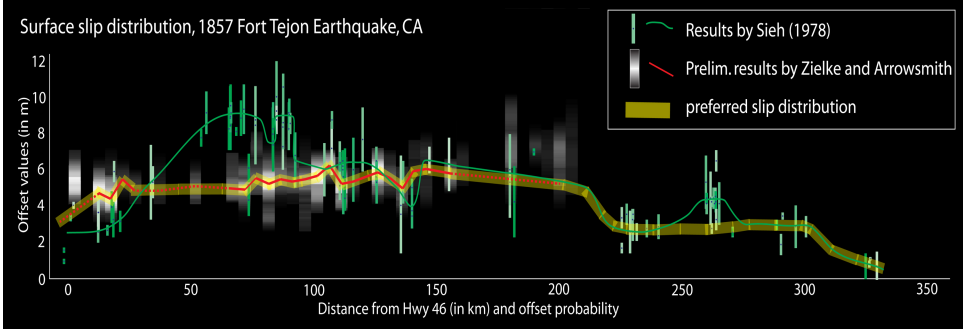
SCEC

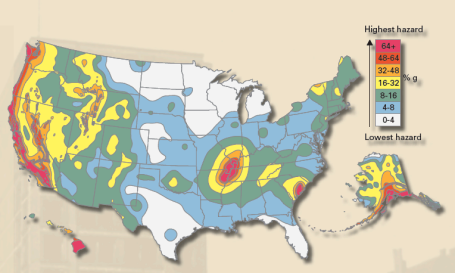
SoSAFE B4 Results



Olaf Zielke & Ramon Arrowsmith (2009)

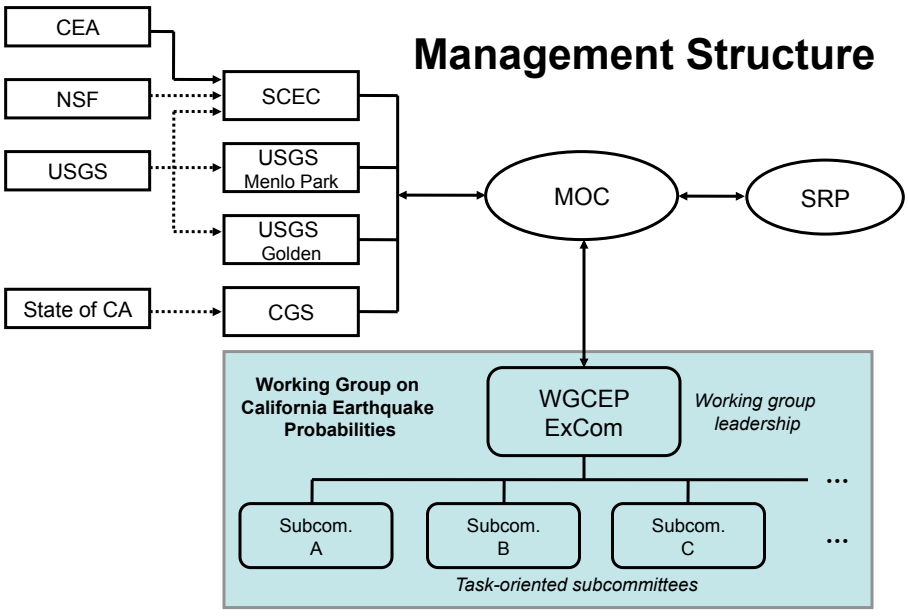
Why now?

- **The USGS will support development of a dynamic UCERF3 in advance of the next NSHMP release, scheduled for 2012-13**
- **Requires delivery of UCERF3 by early 2012**



USGS National Seismic Hazard Mapping Project

Management Structure



UCERF3 Delivery Schedule

Start Date: January 1, 2010

Milestone 1: June 30, 2010

- **Methodology Assessment – Issues and Research Plan (Report #1)**
  - **Written report by WGCEP summarizing the status of the model components, a research plan for addressing outstanding questions and issues, and a preliminary implementation plan for the UCERF3 model. Report will provide details broken out by the main model components and/or by task, as deemed appropriate.**

UCERF3 Delivery Schedule

- **Milestone 2: December 31, 2010**
  - **Methodology Assessment – Proposed Solutions to Issues (Report #2)**
    - **Written report by WGCEP summarizing proposed solutions to the questions and issues identified in Report #1, and a revised implementation plan for the UCERF3 model. Report will provide details broken out by the main model components and/or by task, as deemed appropriate.**

UCERF3 Delivery Schedule

- **Milestone 3: May 31, 2011**
  - **Proposed UCERF3 Plan (Report #3)**
    - **Written report by WGCEP summarizing the proposed implementation plan for the UCERF3 model. This report will identify the remaining implementation issues requiring short-term, targeted research.**

UCERF3 Delivery Schedule

- **Milestone 4: June 30, 2011**
  - **SRP Review of Proposed UCERF3 Plan (Report #4)**
    - **Written report by the SRP that reviews the proposed UCERF3 implementation plan and recommends modifications.**

UCERF3 Delivery Schedule

- **Milestone 5: September 30, 2011**
  - **Final UCERF3 Plan (Report #5)**
    - **Written report by WGCEP that responds to the SRP review (as well as reviews available from NEPEC, CEPEC, and CEA), provides a final implementation plan for the UCERF3 model, and summarizes progress towards implementation.**

UCERF3 Delivery Schedule

- **Milestone 6: March 31, 2012**
  - **Preliminary UCERF3 Model**
    - **Preliminary version of the UCERF3 model by WGCEP, implemented on the OpenSHA computational platform and documented in a written report (Report #6).**

UCERF3 Delivery Schedule

- **Milestone 7: April 30, 2012**
  - **Review of Preliminary UCERF3 Model**
    - **Written report by the SRP that reviews the preliminary UCERF3 model and documentation and recommends modifications (Report #7).**

UCERF3 Delivery Schedule

- **Milestone 8: June 30, 2012**
  - **Final UCERF3 Model**
    - **Final version of the UCERF3 model by WGCEP, implemented on the OpenSHA computational platform and documented in a written report (Report #8).**
    - **This final report will respond to the SRP review (as well as reviews available from NEPEC, CEPEC, and CEA).**
    - **It will also include recommendations to CEA on the use of UCERF3, as appropriate, and recommendations on how UCERF3 can be improved by further research and development.**

Issues for NEPEC and CEPEC

- **Participation in initial UCERF3 meeting**
  - **Scheduled for Dec 1-2, 2009, at the Kellogg West Conference Center in Pomona**
- **Guidelines on the development of UCERF3 as an operational forecasting model**
  - **Validation and testability**
- **Coordination of NEPEC and CEPEC external reviews with SRP internal reviews**
- **Guidelines on the utilization of UCERF3 by USGS, CalEMA, and other agencies**

End

Research Tasks for UCERF3 Model

Task #	Topic	Task Description	UCERF Comp*	CEA Project #	Priority Level
1	Fault modeling	Reconsider endpoints for modeling fault-to-fault rupture probabilities; subdivide sections at closest points to proximate section; add new faults.	FM	1	A
2	Deformation modeling	Evaluate alternative deformation models produced by kinematically consistent methods (e.g., NeoKinema, Harvard-MIT block model, Shen/Zeng model).	DM		B
3	Fault-to-fault ruptures	Relax fault segmentation by considering earthquake rate models that include fault-to-fault ruptures; use inverse methods to estimate self-consistent sets of earthquake rates in unsegmented models; assess the implications for the recurrence rates in California.	ERM	1,2	A
4	Magnitude-area relationships	Consider alternative magnitude-area relationships that are consistent with ground-motion simulations and evaluate their implications for seismogenic depth, aseismicity factors, and coupling coefficients.	ERM		B
5	Slip distribution of fault jumping ruptures	Constrain the magnitude and uncertainty of slip during ruptures that cross fault junctures.	ERM	1,2	A

Research Tasks for UCERF3 Model

Task #	Topic	Task Description	UCERF Comp*	CEA Project #	Priority Level
6	Recurrence intervals	Update recurrence intervals based on new paleoseismic and slip-rate data.	ERM	1,2	B
7	Off-fault seismicity	Develop more quantitative estimates of maximum magnitude for off-fault seismicity, including the UCERF Type-C zones.	ERM		C
8	Time-dependence of historical seismicity	Characterize the seismicity lull in California since 1906, as indicated by the UCERF2 seismicity catalog; resolve the interpretation of the lull in terms of stress evolution; assess the validity and uncertainty of “empirical” time-dependent models.	PM	3,4	B
9	Stress-renewal model	Develop self-consistent stress-renewal models that can accommodate fault-to-fault ruptures; explore the use of physics-based earthquake simulators to obtain such models.	PM	1-4	A
10	Spatial and temporal clustering	Develop time-dependent models for the clustering of earthquakes in space and time, including aftershocks; investigate how earthquake triggering depends on static and dynamic stress changes.	PM	3,4	A

Research Tasks for UCERF3 Model

Task #	Topic	Task Description	UCERF Comp*	CEA Project #	Priority Level
11	Post-event UCERF revision	Develop a time-dependent UCERF that can be rapidly updated following a large earthquake in California.	PM	3	A
12	Cascadia subduction zone	Include the geometry of the Cascadia megathrust into the fault database and fully integrate subduction-related earthquake probabilities into the UCERF	All	3,4	B
13	Loss modeling	Develop loss-modeling tools as a means to quantify the importance of logic-tree branching in representing UCERF epistemic errors.	All		B

UCERF3 Costs by Category

Category	Task (30 mo.)
Geology Staff (USGS & CGS)	$4,486,000
Information Technology Staff	$963,000
Administrative Staff	$312,000
Geological Consultants (SCEC)	$2,575,000
Workshops and Travel	$200,000
Scientific Review Panel	$186,000
Total Project Cost	**$8,722,000**
Requested from CEA (23%)	**$2,000,000**